HABITAT AND AQUATIC INVERTEBRATE ASSEMBLAGES OF EAST ROSEBUD CREEK, CARBON COUNTY, MONTANA

A BIOASSESSMENT STUDY

August 2000

report prepared for

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by
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INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in August 2000 from two sites on East Rosebud Creek, Carbon County, Montana. Aquatic invertebrate assemblages were sampled by personnel of the Montana Department of Environmental Quality (DEQ). Study sites lie within the Montana Valley and Foothills ecoregion (Woods et al. 1999). A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is "...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1995). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998). The first of these is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied is needed to assist in the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998) has recently studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion, and has recommended a battery of metrics specific to that ecoregion, which has been shown to be sensitive to impairment, related to habitat assessment parameters and consistent over replicated samples.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by metals, other toxicants, high water temperatures, or high levels of organic and/or nutrient pollution might be suspected. On the other hand, an "artificial" elevation of biotic condition in the presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment in an oligotrophic setting.

METHODS

Aquatic invertebrates were sampled at two sites by Montana DEQ personnel on August 18, 2000. No location information or site descriptions for these samples was provided. The sampling method employed was that recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). In addition to aquatic invertebrate sample collection, habitat quality was visually evaluated at each site and reported by means of the habitat assessment protocols recommended by Bukantis (1998).

Evaluated habitat features include instream conditions, larger-scale channel conditions including flow status, streambank condition, and extent of the riparian zone. Scores were assigned in the field to each habitat measure, and these scores were totaled and compared to the maximum possible score to give an overall assessment of habitat.

Aquatic invertebrate samples and associated habitat data were delivered to Rhithron Biological Associates, Missoula, Montana, for laboratory and data analyses. In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities in this study, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998) was used. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics, which have been shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics comprising the bioassessment index used in this study were selected because both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998). In addition, they are relevant to the kinds of impacts that are present in the East Rosebud Creek drainage. They have been demonstrated to be more variable with anthropogenic impairment than with natural environmental gradients (Bollman 1998). Each of the six metrics developed and tested for western Montana ecoregions is described below.

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.
3. **Trichoptera (caddisfly) taxa richness.** Caddisfly taxa richness has been shown to decline when sediment deposition affects their habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.
4. **Number of sensitive taxa.** Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998).
5. **Percent filter feeders.** Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* sp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.
6. **Percent tolerant taxa.** Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 1. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger

values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery.

Table 1. Metrics and scoring criteria for bioassessment of streams of the Montana Valleys and Foothill Prairies ecoregion (Bollman 1998).

	score			
metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 - 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 - 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 - 35	> 35

The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3a.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman, unpublished data). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998). In a study of reference

streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).

- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman, unpublished data).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman, unpublished data).

Table 2a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1997)	
% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table 2b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989)	
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for the two sites in this study. Table 3 itemizes the evaluated habitat parameters and shows the assigned scores for each.

Figure 1. Total habitat assessment scores, expressed as percent of maximum, for two sites on East Rosebud Creek, August 18, 2000.

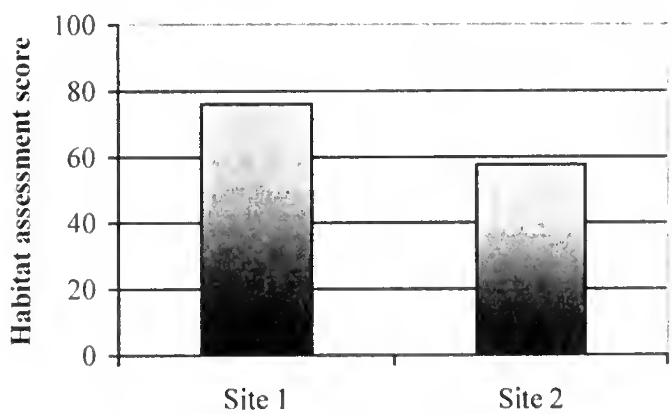


Table 3. Stream and riparian habitat assessment. Site 1 was assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence, while the downstream site (Site 2) assessment was based upon criteria developed for streams with glide/pool prevalence. Incomplete data were provided for Site 2; the score for that site is based only on parameters for which evaluations were available. East Rosebud Creek. August 18, 2000.

Max. possible score	Parameter	Site 1	Max. possible score	**Parameter**	Site 2
10	Riffle development	9	20	Bottom substrate	6
10	Benthic substrate	6	20	Pool substrate char.	7
20	Embeddedness	15	20	Pool variability	7
20	Channel alteration	16	20	Channel alteration	19
20	Sediment deposition	15	20	Sediment deposition	6
20	Channel flow status	15	20	Channel sinuosity	15
20	Bank stability	8 / 8	20	Channel flow status	20
20	Bank vegetation	9 / 9	20	Bank vegetation	6 / 6
20	Vegetated zone	6 / 6	20	Bank stability	N.A.
			20	Vegetated zone	N.A.
160	Total	122	200	Total	92
	Percent of maximum	**76**		Percent of maximum	**57.5**
	CONDITION*	**SUB**		CONDITION*	**SUB**

* Condition categories: Optimal (OPT) > 80% of maximum score; Sub-optimal (SUB) 75 - 56%: Marginal (MARG) 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1988.

Habitat assessment scores indicate sub-optimal habitat conditions at both sites on East Rosebud Creek. At the upper site (Site 1), benthic substrate diversity was limited by an abundance of granitic sand. Slight fine sediment deposition was reported, and channel flow was perceived to be sub-optimal. Streambanks were judged moderately stable and the riparian zone width was slightly abbreviated.

At the downstream site (Site 2), coarse sand limited benthic substrate diversity. Pools were perceived to be few in number and those that were present appeared to have monotonous substrate as well. Sediment deposition, largely sand, was judged substantial. Historic grazing practices were noted as the possible cause of the lack of woody vegetation on streambanks. Bank stability and the extent of the riparian zone were not evaluated.

Bioassessment

Macroinvertebrate taxa lists, metric results, and other information for each sample are given in the Appendix. Figure 2 compares the total bioassessment scores calculated for macroinvertebrate communities collected at each of the two sites. Breakdown of scores for each metric calculated from East Rosebud Creek aquatic invertebrate samples is presented in Table 4.

When this bioassessment method is used to interpret the invertebrate data, scores indicate that Site 1 is fully supportive of its designated uses and supports an essentially unimpaired benthic assemblage. The proportion of tolerant taxa present at the site was

Figure 2. Total bioassessment scores, expressed as percent of maximum, for two sites on East Rosebud Creek. August 18, 2000.

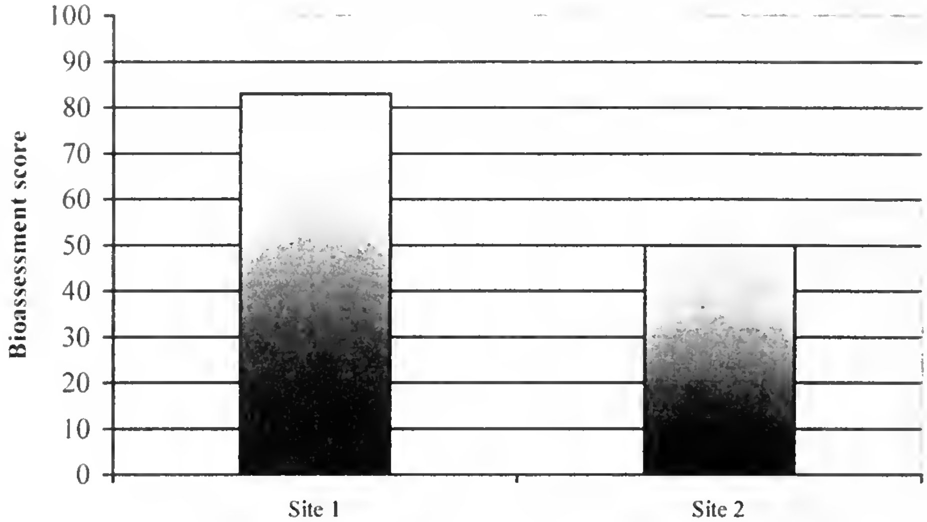


Table 4. Metric values and bioassessments for 2 sites on East Rosebud Creek. August 18, 2000.

	SITES	
	Site 1	Site 2
METRICS	METRIC VALUES	
Ephemeroptera richness	8	5
Plecoptera richness	4	1
Trichoptera richness	7	2
Number of sensitive taxa	3	0
Percent filterers	1	1
Percent tolerant taxa	10	10
	METRIC SCORES	
Ephemeroptera richness	3	2
Plecoptera richness	3	1
Trichoptera richness	3	1
Number of sensitive taxa	2	0
Percent filterers	3	3
Percent tolerant taxa	1	2
TOTAL SCORE (max.=18)	15	9
PERCENT OF MAX.	**83**	**50**
Impairment classification*	**NON**	**MOD**
USE SUPPORT †	**FULL**	**PART**

1. Classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.

*Use support designations: See Table 3a.

slightly higher than expected.

The downstream site (Site 2) partly supported its designated uses and exhibited moderate impairment of biotic integrity. All three insect richness metrics were lower than expected for a foothill stream. No sensitive taxa were collected at the site. Tolerant taxa were slightly more plentiful than expected.

Aquatic invertebrate communities

The eight mayfly taxa collected at Site 1 included the sensitive cold-stenotherm *Drunella doddsi*. Calculation of the modified biotic index (2.66) resulted in a low value. These findings suggest that cold clean water provided an excellent medium for benthic organisms at this site. Small-scale habitats appeared to be intact, since 7 caddisfly taxa and 16 "clinger" taxa were present. Hard substrate surfaces were probably available for colonization, given these data. Shredders were absent from the sampled assemblage and functional components appeared to be skewed toward scrapers (43%); the dominant taxon at the site was the caddisfly *Glossosoma* sp., a particularly effective scraping animal. Riparian shade may have been limited at the site, and riparian inputs of organic material may have been lacking. Alternatively, hydrologic conditions may not have favored retention of such material. Stoneflies were well-represented in the sample. Three perlids were present: *Hesperoperla pacifica*, *Claassenia sabulosa*, and the sensitive *Doroneuria* sp., and 5 other predatory taxa were collected as well. This, along with the fact that at least 30 invertebrate taxa were present at the site, suggests that instream habitats were diverse and plentiful, despite the abundance of sand reported in the habitat assessment.

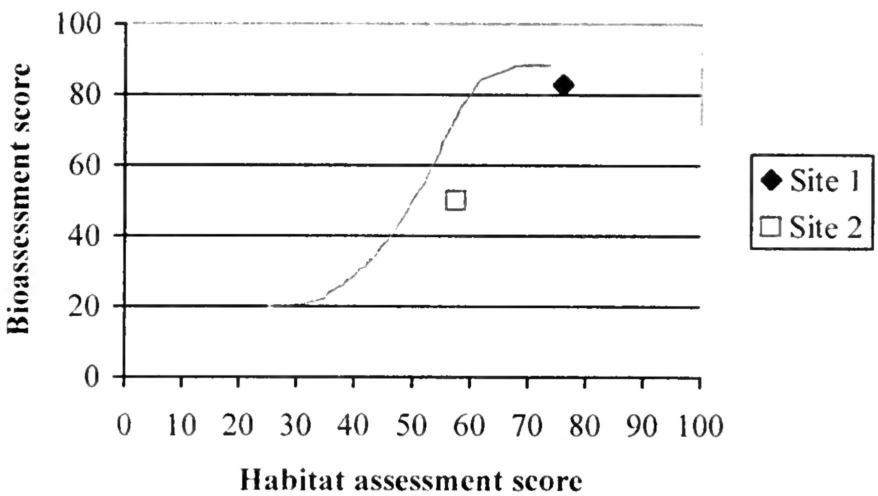
At the lower site (Site 2), however, sandy substrates or fine sediments did appear to limit the benthic community. Only 2 caddisfly taxa and 8 "clinger" taxa were collected in the sample, suggesting a lack of the expected clean hard substrates on the stream bottom. Large-scale habitat features also may have been disturbed or inadequate, perhaps by loss of riparian function, channel alteration, or extensive streambank instability. Low stonefly taxa richness may be a correlate of these habitat features; a single stonefly taxon was represented in the sample. Water quality impairment is suggested by the low mayfly taxa richness; only 5 taxa were present in the sample. In addition, the modified biotic index value (5.42) is somewhat higher than expected for a foothill stream. Impairment of water quality can take several forms, but mild nutrient enrichment is suggested by these observations as well as by the identity and abundance of the dominant taxon, the worm *Nais* sp., which comprised 28%of sampled organisms. Functional composition of the assemblage appeared to be skewed toward collectors, which strengthens the hypothesis of mild water quality impairment at this site.

CONCLUSIONS

- A rich, diverse, sensitive assemblage was present at the upstream site (Site 1). Functional composition suggested that canopy cover may have been limited.
- Mild nutrient enrichment appeared to limit biotic integrity at Site 2. Taxonomic composition of the assemblage also suggested reach-scale as well as small-scale habitat disturbances or inadequacies.
- The relationship between habitat assessment scores and bioassessment scores is illustrated in Figure 3. The red curve in the center of the graph represents the

hypothetical relationship between habitat quality and biotic health when habitat degradation is the sole source of impairment to benthic assemblage health (Barbour and Stribling 1991). Both data points are located very near the curve, suggesting that habitat disturbances or inadequacies are the major influence resulting in slight impairment of biotic health at both sites on East Rosebud Creek.

Figure 3. Total bioassessment scores plotted against habitat assessment scores for two sites on East Rosebud Creek, August 18, 2000. The red line describes the hypothetical relationship expected when water quality is good and biotic health is determined predominantly by habitat quality (Barbour and Stribling 1991).



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APPENDIX

Taxonomic data and summaries

East Rosebud Creek

August 18, 2000

Aquatic Invertebrate Taxonomic Data

Site Name: East Rosebud Creek

Site ID: #1 8/18/00

Approx. percent of sample used: 100

Taxon	Quantity	Percent	HBI	FFG
Acentrella turbida	1	0.33	4	CG
Baetis tricaudatus	9	3.01	6	CG
Drunella doddsi	5	1.67	0	CG
Serratella tibialis	10	3.34	2	CG
Cinygmula sp.	9	3.01	4	SC
Epeorus albertae	1	0.33	1	SC
Rhithrogena sp.	24	8.03	0	SC
Ameletus sp.	2	0.67	0	CG
Total Ephemeroptera	**61**	**20.40**		
Sweltsa sp.	2	0.67	1	PR
Claassenia sabulosa	2	0.67	3	PR
Doroneuria sp.	4	1.34	1	PR
Hesperoperla pacifica	15	5.02	2	PR
Total Plecoptera	**23**	**7.69**		
Arctopsyche grandis	2	0.67	1	PR
Brachycentrus americanus	26	8.70	1	OM
Micrasema sp.	4	1.34	1	MH
Glossosoma sp.	75	25.08	1	SC
Agraylea sp.	3	1.00	8	PH
Dolophilodes sp.	2	0.67	2	CF
Rhyacophila Angelita Gr.	2	0.67	0	PR
Total Trichoptera	**114**	**38.13**		
Heterlimnius sp.	3	1.00	4	CG
Narpus sp.	1	0.33	4	CG
Optioservus sp.	20	6.69	4	SC
Total Coleoptera	**24**	**8.03**		
Ceratopogoninae	1	0.33	6	PR
Simulium sp.	1	0.33	6	CF
Hexatoma sp.	19	6.35	2	PR
Total Diptera	**21**	**7.02**		
Eukiefferiella Brehmi Gr.	3	1.00	4	OM
Eukiefferiella Pseudomontana Gr.	1	0.33	8	OM
Micropsectra sp.	38	12.71	7	CG
Orthocladius sp.	1	0.33	6	CG
Tvetenia sp.	13	4.35	5	CG
Total Chironomidae	**56**	**18.73**		
Grand Total	**299**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: East Rosebud Creek **Site ID: #1 8/18/00**

TOTAL ABUNDANCE	299
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	198
TOTAL NUMBER OF TAXA	30
Number EPT taxa	19

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	0	0	0.00
Odonata	0	0	0.00
Ephemeroptera	8	61	20.40
Plecoptera	4	23	7.69
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	7	114	38.13
Lepidoptera	0	0	0.00
Coleoptera	3	24	8.03
Diptera	3	21	7.02
Chironomidae	5	56	18.73

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	3.54

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	8	47	15.72
Parasite	0	0	0.00
Collector-gatherer	10	83	27.76
Collector-filterer	2	3	1.00
Macrophyte-herbivore	1	4	1.34
Piercer-herbivore	1	3	1.00
Scraper	5	129	43.14
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	3	30	10.03
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	43.00
Scraper/(Scraper + C.filterer)	0.98
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Glossosoma sp.	75	25.08
Micropsectra sp.	38	12.71
Brachycentrus americanus	26	8.70
Rhithrogena sp.	24	8.03
Optioservus sp.	20	6.69
SUBTOTAL 5 DOMINANTS	183	61.20
Hexatoma sp.	19	6.35
Hesperoperla pacifica	15	5.02
Tvetenia sp.	13	4.35
Serratella tibialis	10	3.34
Baetis tricaudatus	9	3.01
TOTAL DOMINANTS	249	83.28

SAPROBIC INDICES

Hilsenhoff Biotic Index	2.66

DIVERSITY MEASURES

Shannon H (loge)	2.65
Shannon H (log2)	3.82
Evenness	0.78
Simpson D	0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	52	17.31
Univoltine	173	57.94
Semivoltine	74	24.75

	#TAXA	ABUNDANCE	PERCENT
Tolerant	3	30	10.03
Intolerant	2	6	2.01
Clinger	16	188	62.88

Aquatic Invertebrate Taxonomic Data

Site Name: East Rosebud Creek
Site ID: #2 8/18/00

Approx. percent of sample used: 20

Taxon	Quantity	Percent	HBI	FFG
Nais sp.	78	27.56	8	CG
Copepoda	1	0.35	8	CG
Acari	3	1.06	5	PA
Total Misc. Taxa	**82**	**28.98**		
Acentrella turbida	1	0.35	4	CG
Baetis tricaudatus	1	0.35	6	CG
Drunella coloradensis	1	0.35	0	CG
Rhithrogena sp.	1	0.35	0	SC
Ameletus sp.	5	1.77	0	CG
Total Ephemeroptera	**9**	**3.18**		
Hesperoperla pacifica	4	1.41	2	PR
Total Plecoptera	**4**	**1.41**		
Hydroptila sp.	2	0.71	6	PH
Oecetis sp.	1	0.35	8	OM
Total Trichoptera	**3**	**1.06**		
Optioservus sp.	25	8.83	4	SC
Total Coleoptera	**25**	**8.83**		
Hexatoma sp.	2	0.71	2	PR
Total Diptera	**2**	**0.71**		
Cricotopus sp.	10	3.53	7	CG
Cricotopus Trifascia Gr.	1	0.35	6	CG
Micropsectra sp.	60	21.20	7	CG
Pagastia sp.	47	16.61	1	CG
Parametriocnemus sp.	7	2.47	5	CG
Polypedilum sp.	5	1.77	6	OM
Potthastia sp.	3	1.06	2	CG
Rheotanytarsus sp.	1	0.35	6	CF
Synorthocladius sp.	1	0.35	2	CG
Thienemanniella sp.	6	2.12	6	CG
Thienemannimyia Gr.	1	0.35	6	PR
Tvetenia sp.	16	5.65	5	CG
Total Chironomidae	**158**	**55.83**		
Grand Total	**283**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: East Rosebud Creek **Site ID: #2 8/18/00**

TOTAL ABUNDANCE	283
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	16
TOTAL NUMBER OF TAXA	25
Number EPT taxa	8

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	3	82	28.98
Odonata	0	0	0.00
Ephemeroptera	5	9	3.18
Plecoptera	1	4	1.41
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	2	3	1.06
Lepidoptera	0	0	0.00
Coleoptera	1	25	8.83
Diptera	1	2	0.71
Chironomidae	12	158	55.83

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.10

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	3	7	2.47
Parasite	1	3	1.06
Collector-gatherer	15	238	84.10
Collector-filterer	1	1	0.35
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	2	0.71
Scraper	2	26	9.19
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	2	6	2.12
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	26.00
Scraper/(Scraper + C.filterer)	0.96
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Nais sp.	78	27.56
Micropsectra sp.	60	21.20
Pagastia sp.	47	16.61
Optioservus sp.	25	8.83
Tvetenia sp.	16	5.65
SUBTOTAL 5 DOMINANTS	226	79.86
Cricotopus sp.	10	3.53
Parametriocnemus sp.	7	2.47
Thienemanniella sp.	6	2.12
Ameletus sp.	5	1.77
Polypedilum sp.	5	1.77
TOTAL DOMINANTS	259	91.52

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.42

DIVERSITY MEASURES

Shannon H (loge)	1.86
Shannon H (log2)	2.68
Evenness	0.58
Simpson D	0.14

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	126	44.35
Univoltine	129	45.41
Semivoltine	29	10.25

	#TAXA	ABUNDANCE	PERCENT
Tolerant	4	29	10.25
Intolerant	0	0	0.00
Clinger	8	46	16.25